

Python - Lists, Arrays, and Data Frames

- Lists are fundamental in Python
- We construct them in a variety of ways
 - Explicit: `my_list = [1,2,3]`
 - Computationally: `my_list.append(4)`
 - List comprehension: `my_list = [x for x in range(4)]`
 - Reading from a file:
with `open(filename, 'r')` as `f`:
`my_list = [line.split('\n') for line in f]`

Python - Lists, Arrays, and Data Frames

- Manipulating lists: **list slicing**
- `My_list[start:stop:increment]`
 - Start - inclusive
 - Stop - exclusive
 - Increment - positive or negative!
 - All can be optional
- Some Examples:

```
>>> lst = [x for x in range(10)]
>>> rev = lst[::-1]
>>> rev
[9, 8, 7, 6, 5, 4, 3, 2, 1, 0]
>>>
```

```
>>> my_list = [1,2,3,4,5,6]
>>> my_list[2:]
[3, 4, 5, 6]
>>> my_list[:2]
[1, 2]
>>> my_list[:]
[1, 2, 3, 4, 5, 6]
>>> my_list[:2]
[1, 3, 5]
>>>
```

Definition: In computer programming, list (array) slicing is an operation that extracts a subset of elements from a list (array) and packages them as another list (array), possibly in a different dimension from the original. (Wikipedia)

```
>>> lst = [x for x in range(10)]
>>> even = lst[::2]
>>> even
[0, 2, 4, 6, 8]
>>> odd = lst[1::2]
>>> odd
[1, 3, 5, 7, 9]
>>>
```

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We can also assign into list slices:

```
>>> lst = [x for x in range(10)]
>>> lst
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
>>> lst[2:5] = [0,0,0]
>>> lst
[0, 1, 0, 0, 0, 5, 6, 7, 8, 9]
>>>
```

```
>>> bit_vec = [1 for i in range(16)]
>>> bit_vec
[1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]
>>> bit_vec[1::2] = [0 for i in range(8)]
>>> bit_vec
[1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0]
>>>
```

For more info see:

<http://www.i-programmer.info/programming/python/3942-arrays-in-python.html>

Python - Lists, Arrays, and Data Frames

Python does not have arrays - they can be constructed with lists of lists.

```
>>> arr = [[1,2,3],  
... [4,5,6],  
... [7,8,9]]  
>>> arr[1]  
[4, 5, 6]  
>>> arr[1][1]  
5  
>>>
```

```
>>> for row in arr:  
...   for e in row:  
...     print(e)  
...  
1  
2  
3  
4  
5  
6  
7  
8  
9  
>>>
```

```
>>> arr[1][1] = 0  
>>> print(arr)  
[[1, 2, 3], [4, 0, 6], [7, 8, 9]]  
>>>
```

```
>>> arr = [[0 for j in range(3)] for i in range(3)]  
>>> print(arr)  
[[0, 0, 0], [0, 0, 0], [0, 0, 0]]  
>>>
```

Python - Lists, Arrays, and Data Frames

However, slicing does **not** work properly on arrays!

```
>>> arr = [[1,2,3],  
... [4,5,6],  
... [7,8,8]]  
>>> arr[1][:]  
[4, 5, 6]  
>>> arr[:,1]  
[4, 5, 6]  
>>> arr[:]  
[[1, 2, 3], [4, 5, 6], [7, 8, 8]]  
>>>
```

Python - Lists, Arrays, and Data Frames

Pandas data frames - 2D arrays specifically designed for data processing!

We will have much more to say about data frames later on

```
>>> import pandas
>>> arr = [[1,2,3],
... [4,5,6],
... [7,8,8]]
>>> df = pandas.DataFrame(data=arr,columns=['a','b','c'])
>>> df
   a b c
0  1 2 3
1  4 5 6
2  7 8 8
>>>
```

```
>>> df.iloc[1,1]
5
>>> df.iloc[1,1] = 0
>>> df
   a b c
0  1 2 3
1  4 0 6
2  7 8 8
>>>
```

Python - Lists, Arrays, and Data Frames

In data frames slicing works as expected!

```
>>> df
  a b c
0 1 2 3
1 4 5 6
2 7 8 8
>>> df.iloc[1,:]
a    4
b    5
c    6
>>> df.iloc[:,1]
0    2
1    5
2    8
```

Python – Classes and Objects

- Classes are dynamic objects in the spirit of Python: variables become defined when they appear in the program text.
- It matters where they appear!
- No protection mechanisms – everything is globally visible!
- Classes also support inheritance (I let you explore that...)

```
In [16]: class Dog:

    kind = 'canine'                # class variable shared by all instances

    def __init__(self, name):      # constructor function -- automatically called
        self.name = name          # instance variable unique to each instance
        self.tricks = []          # another instance variable!

    def __str__(self):             # function to compute string representation of object
        return "{} can do the following tricks: {}".format(self.name, self.tricks)

    def add_trick(self, trick):
        self.tricks.append(trick)
```


Python – Classes and Objects

```
In [12]: Dog.kind
```

```
Out[12]: 'canine'
```

```
In [13]: fido = Dog('Fido')  
         buddy = Dog('Buddy')  
         fido.add_trick('roll over')  
         buddy.add_trick('play dead')
```

```
In [14]: fido.tricks
```

```
Out[14]: ['roll over']
```

```
In [15]: print(buddy)
```

```
Buddy can do the following tricks: ['play dead']
```

Note: this is in Jupyter Notebook style – In is a program statement – Out is the interpreter output

Programming Exercise

- You are to implement Conway's Game of Life in Python:
en.wikipedia.org/wiki/Conway's_Game_of_Life
- Your board size should be a parameter so you can try it on different sized boards
- Your 'number of generations' should also be a parameter
- Your main data structure should be an array – or two if you use *double buffering* (recommended)
- No fancy graphics necessary, just displaying ascii is fine. (see function on next slides)

Programming Exercise

Rules for the Game:

- Any live cell with fewer than two live neighbors dies, as if caused by underpopulation.
- Any live cell with two or three live neighbors lives on to the next generation.
- Any live cell with more than three live neighbors dies, as if by overpopulation.
- Any dead cell with exactly three live neighbors becomes a live cell, as if by reproduction.

Programming Exercise

```
In [24]: import os
import time

def display_array(ar):
    "clear the screen, display the contents of an array, wait for 1sec"
    os.system('clear')

    rows = len(ar)    # grab the rows

    if rows == 0:
        raise ValueError("Array contains no data")

    cols = len(ar[0]) # grab the columns - indices start at 0!

    for i in range(rows):
        for j in range(cols):
            print(ar[i][j],end=' ') # no carriage return, space separated
        print()

    time.sleep(1)
```

```
In [19]: ar = [[1,2,3],
               [4,5,6],
               [7,8,9]]

display_array(ar)
```

```
1 2 3
4 5 6
7 8 9
```

```
In [21]: board = [[' ', '*', ' '],
                  ['*', ' ', '*'],
                  [' ', '*', ' ']]

display_array(board)
```

```
  *
*   *
  *
```

Programming Exercise

```
In [19]: ar = [[1,2,3],  
               [4,5,6],  
               [7,8,9]]  
  
display_array(ar)
```

```
1 2 3  
4 5 6  
7 8 9
```

```
In [21]: board = [[' ', '*', ' '],  
                  ['*', ' ', '*'],  
                  [' ', '*', ' ']]  
  
display_array(board)
```

```
  *  
*   *  
  *
```

Programming Exercise

- Teamwork allowed - see Teams

Teams:

Team 0: Jake Adam, Hennjer, Ryan Richard,

Team 1: Timothy, Samantha N, Korakot,

Team 2: Kenney A, Patrick M, Jared P,

Team 3: Joshua D, Giulia, Shannon Patrice,

Team 4: Phidias, Camren Joseph, Evan Jonathan,

Team 5: Dan Steven, Andrew Michael, Julio,

Team 6: William Jordan, Sofia R, John Francis,

Team 7: Yeury, Timothy Terence,

Team 8: C.J., Joey, Stephanie,

Team 9: Jaeke R, Cody Rithysan, Cole,

Team 10: Zachary T, Tony Levada, Luca G,

Team 11: Emmely, Michael Russell, Joshua Patrick,